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Seorsus a new Gondwanan genus of Myrtaceae with a disjunct distribution in Borneo and Australia

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Abstract

Rye, B.L. & Trudgen, M.E. *Seorsus*, a new Gondwanan genus of Myrtaceae with a disjunct distribution in Borneo and Australia. *Nuytsia* 18: 235–257 (2008). The new genus *Seorsus* Rye & Trudgen (Myrtaceae tribe Chamelaucieae) has four species, two in Borneo and one each in the north of the Northern Territory and the south-west of Western Australia. *Seorsus* is distinguished from related genera by the shape of its anther connective, the orientation of its anther loculi and its distinctly facetted seeds. Two of its four species were previously placed in *Astartea* DC., a third in *Baeckea* L. and the fourth is the new species *Seorsus aequatorius* Rye & Trudgen. Three new combinations, *S. clavifolius* (C.A.Gardner) Rye & Trudgen, *S. intratropicus* (F.Muell.) Rye & Trudgen and *S. taxifolius* (Merr.) Rye & Trudgen, are made. The morphological characteristics, Gondwanan distribution and relationships of the new genus are discussed. Descriptions, keys, illustrations and distribution maps are provided.

Introduction

This paper describes *Seorsus*, a new genus of Myrtaceae tribe Chamelaucieae (*sensu* Wilson *et al.* 2005) with four species, two in Australia and two in Borneo. While *Seorsus* is distinguished primarily by its anther morphology, a more obvious characteristic of the new genus is its stamen arrangement, with the filaments united into fascicles opposite the sepals. This arrangement is common in the related genus *Astartea* DC., but is very rare elsewhere in the Myrtaceae.

It was the presence of antisepalous fascicles that resulted in the two Australian species of *Seorsus* originally being included in *Astartea*. Mueller (1859) described *A. intratropica* from material he had collected in the Roper River area of the Northern Territory, giving an accurate description of its unusual anthers, which have the connective dilated at the base, the loculi facing sideways and a ventral gland. Bentham (1867: 89) was also aware that the anther type of *A. intratropica* was distinctive, separating this species in his *Astartea* key on the basis that it had transverse rather than longitudinal dehiscence (although this is not an entirely correct interpretation of the anther morphology of this species, as discussed in the morphology section below). Later, when Gardner (1942) described the south-western Australian species *A. clavifolia*, he apparently mistook its separated anther loculi for individual anthers, as he recorded twice as many stamens as were actually present.

The existence of a third species of *Seorsus* from the Malaysian part of Borneo was brought to our

attention by Peter Wilson in 2006. Despite having its stamens in antisepalous fascicles, this species was originally described as *Baeckea taxifolia* Merr. (Merrill 1928) and later transferred to the genus *Babingtonia* Lindl. by Bean (1997). A new species of *Seorsus*, occurring in the Indonesian region of Kalimantan, was discovered when herbarium material from Borneo was examined in the current study.

Molecular studies (Lam *et al.* 2002, Wilson *et al.* 2004 and unpublished data), which are discussed in more detail below, have provided evidence that the two Australian species are related to one another, but should not be included in the genus *Astartea*. Our morphological evidence indicates that *Seorsus* is not the only group needing to be separated from *Astartea s. lat.* Like *Seorsus*, the genus *Cyathostemon* Turcz. has long been included partly in *Astartea s. lat.* and partly in *Baeckea* L. *s. lat.* A future paper (Trudgen & Rye in prep.) will reinstate *Cyathostemon*. For convenience, all further references to *Astartea* in this paper will mean *Astartea* in the strict sense, excluding both *Seorsus* and *Cyathostemon*.

The taxonomic significance of the distinctive anthers found in *Seorsus*, and other characters that are of value in either distinguishing the new genus or clarifying its affinities to other genera, are discussed below.

Methods

All measurements were made from dry pressed material. Multiple images of young stems and seeds were taken with a Nikon Digital Camera Head (DS-5M) controlled by a DS Camera Control Unit (DS-L1) and a montage of the images was collated using Synoptics Auto-Montage Pro Version 5.03.0061 software.

Molecular evidence

Recent molecular studies of chloroplast DNA for the tribe Chamelaucieae (Lam *et al.* 2002, Wilson *et al.* 2004), have used the following three regions: the *mat*K gene and the adjacent 5' *trn*K intron, part of the *ndh*F gene and the *atp*B-*rbc*L intergenic spacer. In each of the cladograms presented, a strongly supported clade was obtained comprising all of the species sampled for *Astartea*, *Cyathostemon* and *Hypocalymma* (Endl.) Endl., but excluding the *Seorsus* species.

The phylogenetic tree presented by Wilson *et al.* (2004) included both of the Australian species of *Seorsus*, which formed a clade with moderately high support. This clade was sister, but with weak support, to a clade comprising species of *Aluta* Rye & Trudgen and *Thryptomene* Endl. In a previous analysis (Lam *et al.* 2002), when only *Seorsus intratropicus* was sampled, that species was sister, again with minimal support, to a clade formed by members of *Baeckea* subgenus *Hysterobaeckea* Nied. In both of these studies, *Seorsus* species showed no evidence of any close relationship with the three species sampled of *Astartea*, which were *A. aspera* Schauer, *A. astarteoides* (Benth.) Rye [both included as *A. fascicularis* (Labill.) DC.] and *A. arbuscula* (Benth.) Rye [as *Baeckea arbuscula* Benth.].

Unpublished analyses based on the nuclear ETS region have placed *Seorsus intratropicus* in a weakly supported sister position to the strongly supported *Astartea-Cyathostemon-Hypocalymma* clade (Peter Wilson, pers. comm. 2008). Separation of the latter three genera was also achieved, with

Astartea in a weak sister position to *Cyathostemon* and *Hypocalymma*, which were weakly separated from one another.

It is concluded on the basis of all the available molecular evidence that *Seorsus* is probably more closely related to *Astartea*, *Cyathostemon* and *Hypocalymma* than to any other genera in the tribe Chamelaucieae. However, as *Seorsus* is not found within the strongly supported *Astartea-Cyathostemon-Hypocalymma* clade in any of the chloroplast and nuclear DNA analyses, the molecular evidence supports recognition of this new genus.

Morphology

The main characters that need to be understood in determining the affinities and distinctiveness of *Seorsus* are discussed. As *Astartea, Cyathostemon* and *Hypocalymma* appear to be the closest relatives of *Seorsus* from both morphological and molecular evidence, the similarities to and differences from these three genera are outlined below. The four genera are also compared in Table 1.

Vegetative characters

Habit. Seorsus clavifolius is a medium-sized, erect shrub reaching 1.4 metres tall and *S. taxifolius* has similar stature, reaching 1.3 m tall, but is sometimes described as prostrate on herbarium labels – presumably when it has been collected from exposed situations. A somewhat greater maximum height of 1.7 metres is recorded for *S. intratropicus*. No habit information is available for *S. aequatorius*, but the largest branch on the holotype is over 0.3 m long and its stem diameter suggests a height of over a metre for the plant.

Like many species of *Astartea*, and some species of *Cyathostemon* and *Hypocalymma*, *Seorsus clavifolius* has a marked lignotuberous habit with numerous stems, often 20–40, emerging at ground level. This type of habit is rare among the Chamelaucieae and appears from our field observations to be absent in almost all of the other capsular Western Australian members of the tribe. However, some members of the eastern Australian and South East Asian genus *Baeckea s. str.* are also lignotuberous.

Seorsus intratropicus is probably not lignotuberous (Andrew Mitchell pers. comm.) and there is no information available on this character for the two species from Borneo. Non-lignotuberous species also occur in *Astartea*, *Cyathostemon* and *Hypocalymma*, so there is nothing unusual in having both kinds of habit within a genus. What is unusual is that each of these genera does contain some species with a pronounced lignotuberous habit.

Stems. The four species of *Seorsus* have sub-terete young stems, but with swellings formed by a thick sub-epidermal layer covered by a pale grey epidermis. The arrangement of these swellings, which extend two nodes below the base of each petiole – down to the top of the next petiole of the same orientation – may make the stems somewhat quadrangular. Each patch of pale grey epidermis may be noticeably expanded laterally beyond the margins of the petiole as in *S. taxifolius* (Figure 1C) or more closely lined up with the margins of the petiole as in *S. aequatorius* (Figure 1B). As the young shoots age, the thick sub-epidermal layer dies and becomes transversely fissured, giving the older part of the shoots a distinctive appearance, before it is shed. The fissuring of the stem tissue is particularly broad and deep in *S. taxifolius* (Figure 1C) and is least developed in *S. clavifolius*.

Table 1. Comparison of *Astartea*, *Cyathostemon*, *Hypocalymma* and *Seorsus*.

Genus	*Astartea*	*Cyathostemon*	*Hypocalymma*	*Seorsus*
Distribution	south-west WA, concentrated in extreme south-west	south-west WA, concentrated in the south and extending into interzone	south-west WA, concentrated in northern sandplains	south-west and northern Australia, and high altitudes in Borneo
Flowering branches				
Transversely-fissured stem tissue	absent	absent or rare	absent or rare	present
Leaf fascicles	usually present	absent or slightly developed	absent	absent
Flowers per peduncle	usually 1	1	2–4 in most species	1
Androecium				
No. of whorls	1 or 2	1 or partially 2	2 or 3, rarely almost 1	1 or 2
Stamen number	3–60	8–30	10–120 or more	15–30, 57–78
Stamen fusion	in fascicles or free	in a uniform or partly divided long ring	usually in a uniform short ring	in fascicles
Stamen placement	all or mostly opposite the sepals	continuous or grouped opposite sepals	continuous or rarely opposite sepals	all opposite the sepals
Anther cells	± parallel	± parallel	± parallel or curved	very divergent at base
Connective gland	terminal	terminal	terminal or ventral	ventral
Processes	present	absent	absent	absent
Gynoecium				
Ovules per loculus	1–23	1–9	1–12	6–16
Ovule colouring	usually ± uniform	distinctly two-toned	usually ± uniform	uniform
Style base	close to placentas	close to placentas	close or distant	distant from placentas
Stigma	peltate	usually capitate	usually capitate	peltate
Fruit				
Position	± half-inferior	usually largely superior	± half-inferior to superior	largely inferior
Wall and valves	usually thin	thick	thick	thin
Functional loculi	1–3	2 or 3	1–4	2 or 3
Seeds				
Seed facets	absent or poorly developed	absent or very poorly developed	absent or very poorly developed	pronounced
Length	0.5–1.3 mm	1.3–2 mm	0.8–2.3 mm	0.6–1.4 mm
Embryo	broadest near base	broadest near apex	broadest near base	broadest near base
Testa thickness	usually rather thin	thick	thick	thick
Inner proliferation	curved	curved	curved	angular or absent

Astartea, *Hypocalymma* and *Cyathostemon* show great variety in their stem morphology; for example their young shoots can be prominently winged, or have a variety of types of tubercles (Figure 1A) or hairs. The epidermis and underlying tissue are usually shed in longitudinal strips (Figure 1A) or may be somewhat more fibrous or shed in patches. Transverse fissures similar to those found in *Seorsus* have been observed in a few species of *Cyathostemon* and *Hypocalymma* but not in *Astartea*.

Leaves. In *Astartea* many species have most of their leaves crowded on short shoots into leafy fascicles, although widely spaced pairs of leaves are also quite common on rapidly growing stems. *Cyathostemon* has some species with the leaves crowded onto short shoots, but less obviously than in *Astartea*, while *Hypocalymma* shows no tendency for the leaves to be in fascicles. The fasciculate leaf arrangement is also completely absent in *Seorsus*, which has leaves in pairs fairly uniformly distributed along the branchlets.

The leaves in *Astartea* are consistently thick and narrow, with a poorly defined petiole but usually with sharply defined margins. The species of *Seorsus* from Borneo and northern Australia also have thick narrow leaves with a poorly defined petiole (Figure 1B & C). However, the south-western Australian species, *S. clavifolius*, differs in having a well-defined petiole and a shorter blade with a slightly to distinctly broader shape. In both *Cyathostemon* and *Hypocalymma* the leaves are more varied, ranging from broad and flat to thick and narrow.

Inflorescence

All *Seorsus* species have solitary, pedunculate, axillary flowers. The number of flowers on a branchlet varies from two (rarely only one developing) to about 16. The flowers can be in the upper leaves of a branchlet (sometimes appearing to be terminal, but with the stem bud present and probably dormant), or well away from the growing tip. Each peduncle is terminated by a pair of opposite bracteoles, above which the pedicel is about as long as the peduncle in *S. clavifolius*, but shorter than the peduncle in *S. intratropicus* and absent in the two species from Borneo.

Cyathostemon is similar to *Seorsus* in having solitary axillary flowers, but differs in its better-developed pedicels, which are usually much longer than the peduncles. *Astartea* is similar to *Seorsus* in having its peduncles well developed and its pedicels varying from well developed to more or less

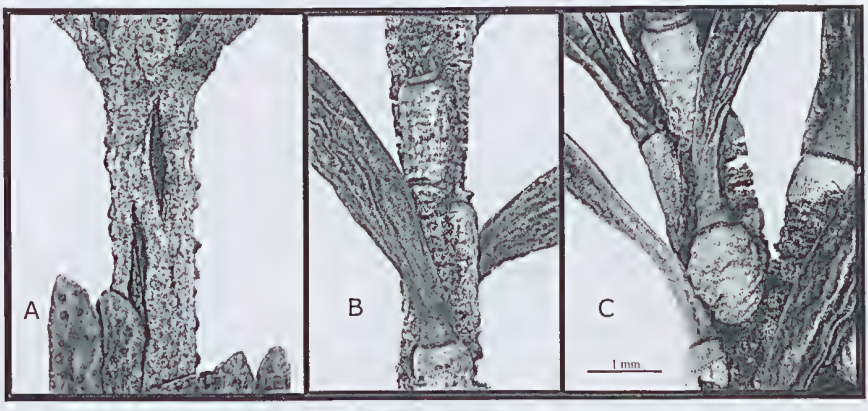

Figure 1. Epidermis appearance and dehiscence patterns on young leafy stems. A – *Astartea aspera* Schauer; B – *Seorsus aequatorius*; C – *Seorsus taxifolius*. Digital images prepared by Alex Williams from *B.E. Hall* 30a (A), *H. Hallier* 2308 (B) and *I. Paie* S.26456 (C).

absent. *Hypocalymma* can usually be readily distinguished from the other genera by its inflorescence, as most species have pairs of more or less sessile flowers in a leaf axil. However a few species of *Hypocalymma* have long peduncles and/or pedicels, and some regularly produce solitary flowers, although there can be up to four flowers per axil.

Among the *Seorsus* species, the bracteoles vary from leaf-like to partially scarious. The largest, most persistent, bracteoles are those of *S. taxifolius*, these being leaf-like and about 3 mm long. There is also considerable variation in bracteole morphology among the other three genera.

Androecium

Stamen number. In the two Australian species of *Seorsus*, the number of stamens varies not only between flowers on the same plant but also between fascicles in the same flower. *Seorsus clavifolius* has moderately numerous stamens (17–23) and *S. intratropicus* has very numerous stamens (57–78). However, the two species from Borneo seem to have relatively constant numbers of stamens per fascicle and per flower. In *S. aequatorius* there are usually six stamens per bundle and 30 stamens per flower, while *S. taxifolius* usually has three stamens per bundle and 15 stamens per flower. Each of these four species can therefore be distinguished from the others by its stamen number.

The other three genera have a continuous range of stamen numbers, from 3 to 60 in *Astartea*, from 8 to 30 in *Cyathostemon*, and from 10 to over 120 in *Hypocalymma*.

Stamen arrangement. In *Seorsus*, all of the stamens are in well-defined antisepalous fascicles, with two to 18 stamens per fascicle. Antisepalous fascicles are also common in *Astartea*, with up to 13 stamens each, but fascicles are sometimes poorly defined and are not always present. Those species of *Astartea* with a much reduced number of stamens have only free stamens, whereas those species with high numbers of stamens sometimes have a mixture of antisepalous fascicles and solitary antipetalous stamens or staminodes; or if they only have fascicles the long marginal filaments may loose the anther to form staminodes.

In *Hypocalymma*, which often has very numerous stamens united at the base into a continuous ring of uniform height, there are usually two or three adjacent whorls of stamens, with stamens of the innermost whorl shortest. *Cyathostemon* species have a single whorl of stamens when there are few of them but sometimes have a partial shorter second whorl when stamens numbers are higher. The filaments are flattened in *Cyathostemon* and are all united at the base into a tube but the individual stamens vary in length and are fused for varying lengths, sometimes superficially giving the impression of fascicles. Often there are alternating long and short stamens around the ring.

Seorsus intratropicus has its numerous stamens densely clustered into the fascicles (Figure 2H), which spread out at the base so that their margins extend towards the adjacent fascicles but do not join them. The stamens are in two whorls, the outer whorl longer than the inner one but with both whorls having a general progression from the longest filaments on the margins of each fascicle to the shortest in the centre. The two whorls are fused for much of the length of the filaments, with the filaments located on the margins of the fascicle fused for a shorter length than the next pair in. As a result of both their greater overall length and shorter length of fusion, the free part of the marginal stamens tends to be much longer that that of the other filaments. Exactly the same arrangement of the stamens of each fascicle can be seen in *Astartea* species that have large numbers of stamens per flower.

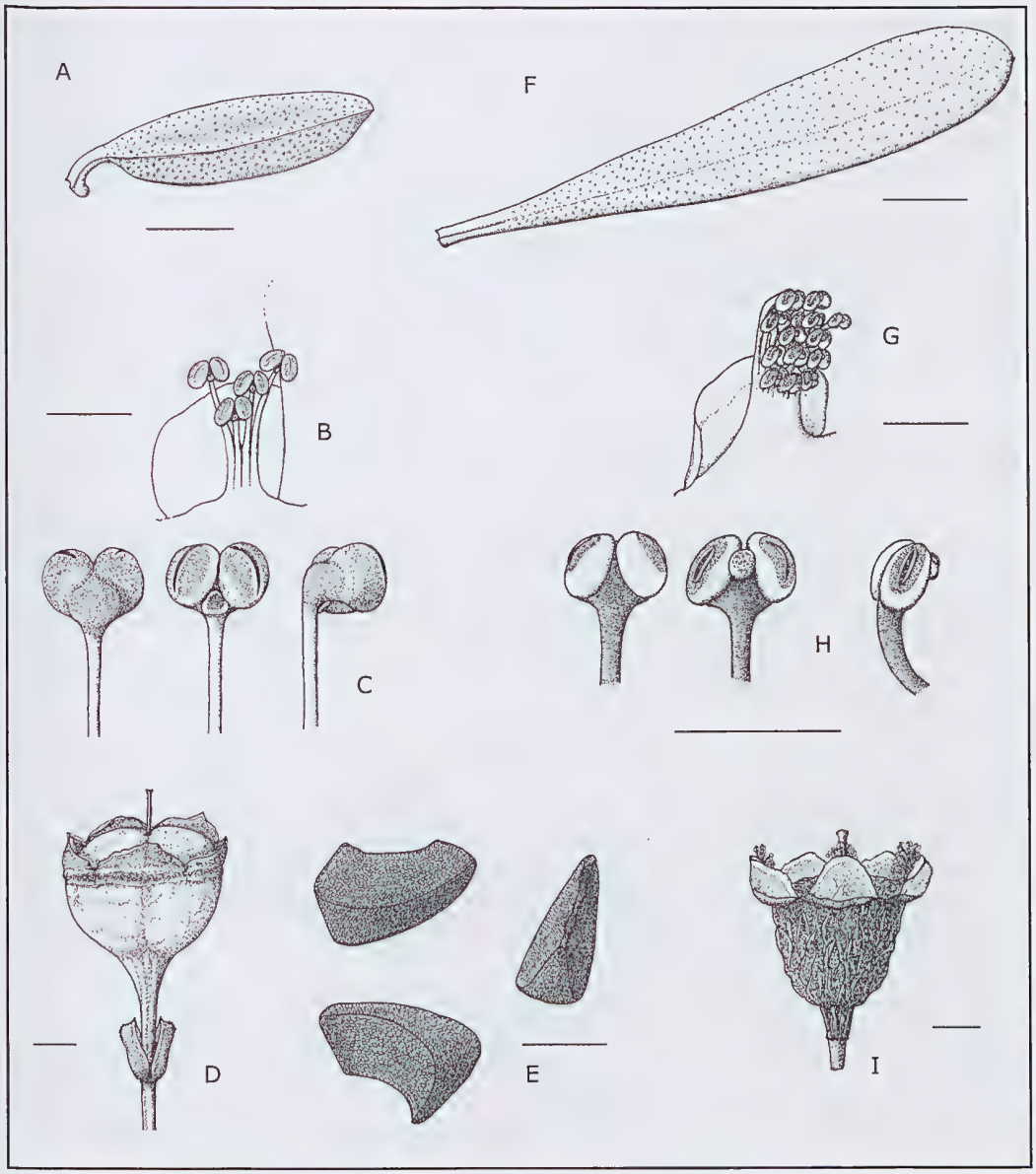

Figure 2. A–E. *Seorsus clavifolius*. A – leaf; B – stamen fascicle; C – three views of anther; D – bracteoles and fruit prior to dehiscence; E – three views of seed; F–I. *Seorsus intratropicus*. F – leaf; G – stamen fascicle;H – three views of anther; I – young fruit with three of the five stamen fascicles still attached. Scale bars all 1 mm. Drawn by Lorraine Cobb from *D. Papenfus* 721 & *K. Macey* (A–E) and *P.K. Latz* 10117 (F–I).

With only 2–6 stamens in each fascicle, the arrangement of the stamens in *Seorsus clavifolius* is simpler and more obvious. The fascicles arise more abruptly at the base so that their margins are more or less parallel, with the stamens arranged in a single whorl and the filaments becoming progressively shorter from the margins to the centre (Figure 2C). The two *Seorsus* species from Borneo, and also those *Astartea* species that have similar stamen numbers, match *S. clavifolius* in the arrangement of stamens in their fascicles. A similar arrangement of short and long stamens occurs in at least one species of *Cyathostemon* and in *Hypocalymma cordifolium* subsp. *minus* Keighery & Strid, although in the

former the stamen groups are united also to one another to form a complete ring and in the latter the filaments are separated at the base rather than being united. Of all the species in the latter two genera, *Hypocalymma scariosum* Schauer is the only one that sometimes has true antisepalous fascicles. When stamen numbers are reduced in that species to 12–15 per flower, there are gaps opposite the petals and the contiguous filaments are very shortly united at the base into slight fascicles with the outermost stamens longest.

While the consistent arrangement of the longest stamens outermost in antisepalous fascicles may seem peculiar, it reflects the general tendency among the Myrtaceae for the longest stamens to be opposite or closest to the centre of each petal and the shortest stamens to be opposite or closest to each sepal. This means that when stamen fascicles are produced opposite the petals, as in genera such as *Melaleuca* L., the longest stamens are located at the centre of the fascicle.

Stamen type. The stamens of *Seorsus*, *Astartea*, *Cyathostemon* and *Hypocalymma* all have non-versatile anthers with the filament flattened at the base where it joins the staminophore.

The attachment of the filaments to the connective is more variable, ranging from truly basifixed, through attached very close to the base of the connective, to attached to the lower part of the back of the connective. In *Seorsus*, the top of the filament broadens where it joins the connective, which is noticeably broader at the base than in the upper part. Below this broad connection, the free part of the filament is narrow. In the other three genera, the connective usually remains the same width from top to bottom and certainly never broadens markedly at the base as in *Seorsus*.

Anther loculi. In all species of *Seorsus*, *Astartea*, *Cyathostemon* and *Hypocalymma*, the anther loculi are longer than wide and open by longitudinal slits. However, the orientation of the loculi varies in two ways. Firstly, the loculi can vary from being side by side and facing inwards (introrse) through to being back to back (fully latrorse), but with their long axes still remaining parallel to each other and to the long axis of the connective. Secondly, they can diverge either at the base or at the top so that they are no longer parallel to the connective or to each other. The latter morphology only occurs in species where the loculi are partially to fully latrorse.

In *Seorsus*, the anther loculi are always latrorse and also well separated at the base so that they are very distinctly inclined towards one another at the top (Figure 2C & H). While there is much variation in *Astartea*, both between and within species, the most common situation is for the loculi to be both introrse and parallel. However, if the loculi are more latrorse, they may rarely be somewhat inclined away from one another at the base, but never approaching the degree of inclination found in *Seorsus*.

The large degree of inclination (*c.* 45 degrees from each axis of the connective) of the loculi in *Seorsus* is sufficient to give a very different appearance to the anthers compared to those of *Astartea*, *Cyathostemon* and *Hypocalymma*. Bentham (1867) described *Astartea fascicularis* and *Cyathostemon* [as *Astartea ambigua*] as having anthers with longitudinal dehiscence and those of *Seorsus intratropicus* [as *Astartea intratropica*] as having transverse dehiscence. In fact the dehiscence is still along the length of the loculi, not across them; what has changed is the orientation of the loculi, not the direction of dehiscence.

Connective gland. In most genera of the Myrtaceae, including *Astartea* and *Cyathostemon*, the connective gland is located on the outer, i.e. dorsal, surface of the anther at the distal end of the

connective. However, in *Seorsus* the connective gland is visible on the inner, i.e. ventral, surface of the anther. The position of the gland varies from being terminal on the ventral surface of the connective as illustrated for *S. intratropicus* (Figure 2H) to being close to the base of this surface as illustrated for *S. clavifolius* (Figure 2C), although the position often varies between these extremes even between stamens of the same fascicle. The two species from Borneo have very similar anther morphology to the two Australian species.

This apparent change in the position of the connective gland in relation to the loculi is an unusual phenomenon in the tribe Chamelaucieae. However, a somewhat similar development is found in a number of *Hypocalymma* species. In these species the anther loculi are often markedly curved, separating from one another at the middle around an apparently ventral connective gland but converging with one another at the top and base of the anther, as illustrated in Rye (1987: fig. 155D).

Processes. Small hair-like structures that are inserted between the petals and stamens are common in some genera of the Chamelaucieae and are referred to as processes. They are often present in *Astartea*, but have not been found in *Seorsus*, *Cyathostemon* and *Hypocalymma*.

Gynoecium and fruit

Depth of insertion of style base. Each of the *Seorsus* species has an inferior ovary that is fused to most of the length of the hypanthium and has a broad disc across its summit. At the centre of the disc there is a depression where the terete base of the style is inserted between the two, or more commonly three, loculi. In *Astartea*, *Cyathostemon* and most other capsular members of the tribe Chamelaucieae, the style base is inserted into a long tubular depression reaching down to the level of the placentas. An interesting feature of the gynoecium in *Seorsus* is the shallowness of the depression in the disc, resulting in a distinct gap between the base of the style and the area of attachment of the placentas to the central axis of the ovary. This gap is filled with a relatively soft tissue and is longer in *S. clavifolius* than in the other three species of *Seorsus*. All species of *Hypocalymma* have a 2–4-locular ovary and most have the style base deeply inset. However, some *Hypocalymma* species have an unusual modification in which the style base is not inserted at all but instead enlarges at its base and grades into the top of the ovary.

Stigma. At maturity the stigma in *Seorsus* is peltate, with that of *S. taxifolius* quite large and the others smaller. There is a tendency for *Astartea* to have large peltate stigmas and *Hypocalymma* and *Cyathostemon* to have capitate stigmas, but there are exceptions.

Fruit. In *Seorsus*, the fruit is a 2- or 3-valved capsule with quite thin walls. It is largely inferior, being fused to the hypanthium for about two-thirds to three-quarters of its length. In contrast, in *Astartea* the capsule is about half inferior and in most *Cyathostemon* and *Hypocalymma* species the capsule is largely superior. However, the species of *Cyathostemon* currently known as *Astartea heteranthera* C.A.Gardner has its fruit about half inferior.

The outer wall of the capsule (including the hypanthium) and the valves of many *Astartea* species are similar in texture to those of *Seorsus* species. In contrast, a thicker harder wall and valves are found in *Cyathostemon* and most *Hypocalymma* species, and there is some tendency in *Astartea* for thick walls and valves to develop too, especially in the group related to *A. aspera*.

Seeds. Like the related genera *Astartea*, *Cyathostemon* and *Hypocalymma*, *Seorsus* species have a crustaceous testa, a feature found in all members of the tribe Chamelaucieae that have a dehiscent fruit. In this tribe, crustaceous seeds vary from having a continuously curved shape, such as reniform or ovoid, to being highly angular in shape with distinct facets. The term facet is used here to describe flattened or curved parts of the testa surface separated from other parts of the testa by a definite angle.

Seorsus has seeds that are distinctly facetted, with the base (i.e. the part adjacent to the central axis of the fruit) larger than the distal end. Usually, each seed has five facets, the largest of which is its rounded back which curves strongly at the base. There are also two equal-sized flat facets forming its sides (the surfaces that abut adjoining seeds) and two much shorter and narrower facets to the inside. One of the small inner facets (the basal one) abuts the placenta and includes a small hilum, while the distal one abuts the seed that is attached to the opposite side of the placenta. The distal inner facet is usually narrower than the basal one and is sometimes reduced to a rounded edge so that the seed has only four facets. The position of the hilum on the basal inner facet varies from almost terminal to about half way down its length.

Figure 3. A – lateral view of seeds from *Astartea aspera*; B – lateral and adaxial views of seeds from the *Cyathostemon* species that is currently known as *Astartea heteranthera*; C – lateral view of two seeds, still attached to their placentas, from *Hypocalymma angustifolium* (Endl.) Schauer; D – oblique and adaxial views of seeds from *Seorsus aequatorius*; E – lateral and adaxial views of seeds from *Seorsus intratropicus*. Digital images prepared by Alex Williams from *B.E. Hall* 30a (A), *B.L. Rye* 239099 *& M.E. Trudgen* (B), *B.L. Rye* 241206, *F. Hort & J. Hort* (C), *H. Hallier* 2308 (D) and *P.K. Latz* 10117 (E).

The three tropical species have similar seeds with an obtuse angle on the inside formed by two narrow, more or less flat inner facets or with the basal facet slightly incurved (Figure 3D & E). The seeds of the fourth species, *Seorsus clavifolius* from south-western Australia, differ in that the inner facet abutting the placenta is more deeply incurved (Figure 2E). The angular seeds of *Seorsus* differ markedly from those of *Astartea*, *Cyathostemon* and *Hypocalymma*, in which the outer surface grades into the sides gradually rather than being separated by sharp angles (Figure 3A–C). These three genera all show further differences from *Seorsus* in their seeds, in characters such as seed size, orientation in the locule and testa thickness and ornamentation, some of which are listed in Table 1.

All four genera have a modified region on the inner part of the seed, which may have been formed by a down-turning and fusion of the narrow end of the seed onto the main part of the seed. The embryo, like the cavity in which it is contained, is restricted to the main part of the seed and is narrowest at the end where the modified region originates. The size and distinctness of the modified area varies, often even on seeds from the same fruit. It can have a distinctive colour (Figure 3A & C) or be similar in colour to the remainder of the seed (Figure 3B). In some species, such as *Astartea* sp. Mt Johnson (A.R. Annels 5645), this area has evolved to function as a "soft fleshy elaiosome" (Hutchison 1997: 36, fig. 9a). In other species it may have different functions, perhaps sometimes acting as a false elaiosome. In taxa where it is very reduced, sometimes to the point of being apparently absent as in *Seorsus clavifolius*, it may now be redundant.

On seeds of the three tropical species of *Seorsus*, the modified area includes the distal inner facet and is visible from side view, comprising cells that are aligned parallel to the facet and more or less at right angles to those of the main part of the seed (Figure 3D & E). The distinct area of cells forming the upper facet is not present in the south-western Australian species, *S. clavifolius* (Figure 2E), although on some seeds there are small areas where the cells have a somewhat similar alignment. However, when seeds of this species are cut parallel to the sides, the top can be clearly seen to have turned down as in other species of *Seorsus*.

Chaff. In *Seorsus* the unfertilised ovules or aborted seeds, also known as chaff, may look very similar to the fully developed seeds or they may be similar but distinctly narrower. For example, in one 2-locular fruit examined of *S. clavifolius* there were 16 apparent seeds, eight in each loculus, but only two from each loculus were found to be true seeds when cut open. The 14 pieces of chaff tended to have a thicker crustaceous wall but much less content than the seeds, with the enclosed material of a drier, somewhat harder, texture and somewhat darker that the soft white tissue inside the seeds. In contrast, in *Astartea*, *Cyathostemon* and *Hypocalymma* the chaff are quite different from the seeds, at least in size, and often also much softer and a different colour.

Distinction and affinities of *Seorsus*

The morphological and molecular evidence discussed above indicates that *Seorsus* is related to *Astartea*, *Cyathostemon* and *Hypocalymma*. Both *Cyathostemon* and *Hypocalymma* are readily distinguished from *Seorsus* by the way their stamens are arranged, as well as by a variety of vegetative, inflorescence, anther, fruit and seed characters. *Astartea* shows the greatest similarity in morphology to *Seorsus*, being the only other member of the tribe Chamelaucieae in which well-defined antisepalous stamen fascicles occur. Other characters the two genera share include the occurrence of a marked lignotuberous habit (although not universal in either genus), solitary axillary flowers with the pedicels varying from absent to about the same length as the peduncles, stamens with the filament attached at

or near the base of the connective, similar seed size and the presence of a modified area on the inner surface of the seeds.

This leaves the question of whether or not *Seorsus* shows sufficient morphological differences from *Astartea* to justify its recognition as a distinct genus. To summarize the main differences outlined in the previous section, *Seorsus* differs from *Astartea* in:

- the breaking down of the sub-epidermal tissue of the young shoots by multiple transverse fissures;
- lacking clustering of the leaves into fascicles;
- the lack of processes adjacent to the claw of the petals;
- the shape of the anther connective;
- the orientation of the anther loculi on the connective;
- the distinct separation of the style base from the placentas;
- having a greater proportion of the fruit inferior;
- having strongly facetted seeds;
- the chaff being quite similar in appearance and texture to the seeds.

We believe that the seed and anther differences alone are sufficient to justify the erection of *Seorsus*, with the stem tissue type, leaf arrangement, style base position and degree of inferiority of the fruit also being significant characters distinguishing the two genera. The particular combination of anther characters found in *Seorsus* is sufficient for anther type to be used alone to identify this genus from all other members of the Chamelaucieae.

Recognition of the genus *Seorsus* is also supported by the molecular data, as discussed earlier. *Seorsus* and *Astartea* also differ in their distributions and habitat preferences as outlined below.

Distribution and habitat

The current geographic range of *Seorsus*, extending for about 4,000 km from Borneo to southern Australia (Figure 4A), is far greater than that of the related three genera *Astartea*, *Cyathostemon* and *Hypocalymma*, all of which are restricted to south-western Australia. In fact, the only genus within the entire tribe Chamelaucieae found over a greater distance is *Baeckea s. str.*, which extends from southern China to Tasmania.

Although *Seorsus* is a widespread genus, each of its four species is only known from a very small area and each of these areas is well separated. The disjunction between the two Australian species is about 2400 km and the distance between the localities of the two species in Borneo is over 600 km. Both of the latter species occur on mountains. *Seorsus taxifolius* occurs at high altitudes (over 2000 m) on the rocky slopes of the sandstone mountain Mt Murud, while *S. aequatorius* occurs on a relatively isolated mountain, Mt Kelam, with a bald broad granite summit less than half as high as Mt Murud. One of the Australian species, *S. intratropicus*, also has a rocky habitat in the tropics, but at lower altitudes, occurring in cracks in sandstone pavements in the north of the Northern Territory.

The other Australian species, *Seorsus clavifolius*, occurs in a temperate rather than tropical climate, in sandy soils on the margins of salt lakes in the south-west of Western Australia. It occurs within the regions occupied by both *Cyathostemon* and *Hypocalymma* but just outside the known range of

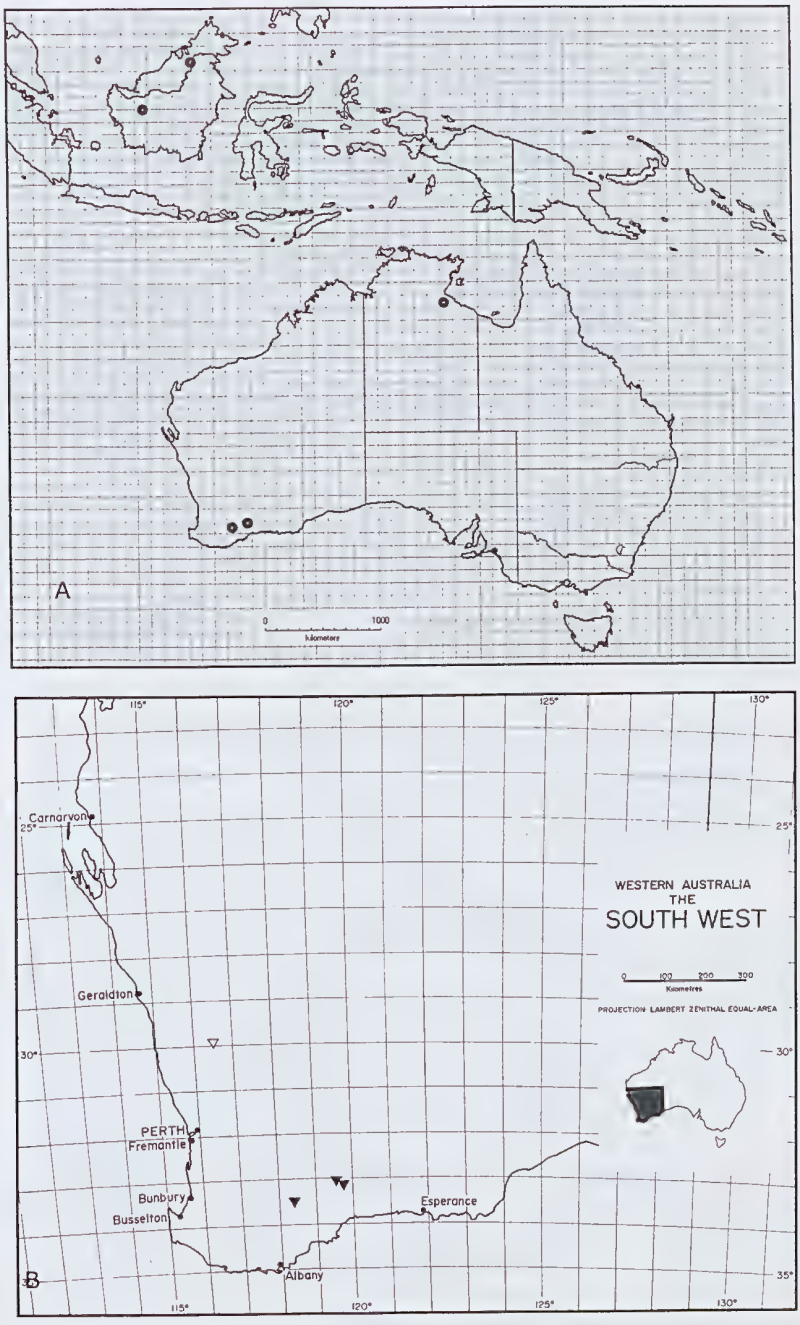

Figure 4. Distribution maps. A – the genus *Seorsus*; B – *Seorsus clavifolius* (▼), with the apparently inaccurate type locality (▽).

Astartea. Its habitat on the margins of salt lakes also differs from that of *Astartea*, which occurs in habitats associated with fresh water.

About half of Borneo appears to have been derived from four blocks originating from Gondwana, with a much smaller portion derived from two blocks from Indochina, and the rest of more recent origin, although when and how the amalgamation of the various parts took place are far from certain (Michaux 1991). Mt Kelam, the granitic mountain where *Seorsus aequatorius* occurs, is on by far the largest of the Gondwanan blocks. Mt Murud, on which *S. taxifolius* grows, does not appear to be of Gondwanan origin; however it is situated not far from a small block thought to have originally been located between what are now Western Australia and India.

Given the distribution of the genus in areas that were once part of Gondwana and the small and very widely separated areas of occurrence of the four species, it seems appropriate to consider *Seorsus* to be a relictual genus with a history predating the break-up of Gondwana. Major disjunctions occur within Australia in a few genera of tribe Chamelaucieae, and one genus, *Sannantha* Peter G.Wilson (Wilson *et al.* 2007), is disjunct between the eastern coast of Australia and New Caledonia. However, in no cases are these disjunctions as great as the distance separating the two Australian species of *Seorsus*.

Key to *Seorsus* and related taxa

1. Young stems with thick sub-epidermal tissue that becomes transversely fissured before being shed. Anther loculi close at the apex but very divergent at the base; connective triangular, with a wide basal attachment. Seeds strongly facetted ..... **Seorsus**

1: Young stems usually with outer tissue shed in longitudinal strips or in patches. Anther loculi more or less parallel; connective not much broader at the base than at the top. Seeds not facetted or with facets poorly developed

2. Stamens 8–30, united into an undulating or fairly level petaline ring (the leaves always opposite-decussate). Embryo (and the seed cavity containing it) broadest towards the apex of the fruit ..... **Cyathostemon**

2: Stamens 3–125 in varied arrangements (if androecium as above then leaves in whorls of three). Embryo and seed cavity broadest towards the base or lateral margins of the fruit loculi

3. Leaves tending to be fasciculate and always narrow. Stamens 3–60, when very few then all or mostly widely spaced, when more numerous then all or mostly in antisepalous fascicles. Seeds 0.5–1.3 mm long, thin-walled in most species ..... **Astartea**

3: Leaves narrow or broad but never fasciculate. Stamens 10–125, basally united into a continuous circle or, when few, sometimes with gaps present. Seeds 0.8–2.3 mm long, thick-walled ..... **Hypocalymma**

Descriptions

Seorsus Rye & Trudgen, *gen. nov.*

Frutices glabri. Folia opposita, decussata, parvula. Flores solitarii in axillis foliorum positi. Sepala 5, in fructu persistentia. Petala 5, ungue basali brevi. Androecium ex staminibus in fasciculo antisepalum; antherae basifixae, cellulis basaliter divergentibus, longitudinaliter dehiscentibus, connectivo ad basim latissimo, glande adaxiali. Ovarium 2- vel 3-loculare, loculis 6–16-ovulatis; placentae axiales, peltatae. Styli basis in depressione inserta. Fructus siccus, 2- vel 3-valvatus. Semina crustacea, faceta.

Typus: *Seorsus clavifolius* (C.A.Gardner) Rye & Trudgen.

Shrubs prostrate or erect and up to *c.* 1.7 m high, often widely spreading, glabrous; branchlets with each petiole borne at the summit of a swelling, with a smooth pale grey epidermis covering a thick transversely fissured layer. *Leaves* opposite and decussate, spreading, small, entire, shortly or very shortly petiolate; lamina obovate or oblong-elliptic to almost linear, thick, dotted with small oil glands. *Inflorescence* of solitary axillary flowers, usually with few but sometimes up to 12 flowers per branchlet. *Peduncles* short, straight, with two opposite bracteoles at the summit. *Bracteoles* usually persistent, leaf-like or with a herbaceous keel and more scarious margins, the margins somewhat to very incurved. *Pedicels* short or absent. *Buds* more or less truncate. *Flowers* predominantly 5-merous, occasionally 6-merous, white or creamy white, sometimes with a slight pink flush, protandrous. *Hypanthium* with an obconic or broadly obconic adnate part and more spreading free part; adnate part with a coarse and irregular reticulate-rugose patterning; free part less prominently patterned and shorter than adnate part. *Sepals* usually 5, fairly erect in flower, persistent in fruit, depressed ovate to semicircular, with an incurved herbaceous keel which is smooth to distinctly ridged or shortly horned dorsally, the margin somewhat scarious. *Petals* usually 5, widely spreading, not persistent in fruit, broadly obovate to circular, broadly clawed at base. *Androecium* of 15–78 stamens, in distinct fascicles of 2–18 stamens opposite the sepals, the filaments united into a long compressed claw within the gap between the petal claws, with the longest stamens of each fascicle closest to the petals and shortest ones on the inside; staminodes and processes absent. *Stamens* shorter than the petals and exceeded by the stigma when the style is mature, curved inwards, the free portion terete. *Anthers* with a broadly triangular connective, not versatile, with latrorse loculi that are well separated at the base but more or less meet at the apex; loculi broadly elliptic from top view, longitudinally dehiscent; connective gland large, more or less globular, located to the inner surface of the connective facing inwards towards style. *Disc* level around a slightly raised centre, dotted with oil-glands. *Ovary* inferior, adnate to hypanthium for its full length in flower but expanding above base of the free hypanthium in fruit, 2- or 3-locular; placentas axile, attached above centre of ovary, large, either flattened and very broadly attached or conic and peltate with a central very short stalk, without a longitudinal slit between the ovules; ovules 6–16 per loculus, usually variable in number between loculi, either radially arranged and all meeting at centre of placenta or arranged in two closely meeting rows along the length of the placenta and with ovules radiating at each end connecting the rows. *Style* narrowly cylindric, base inserted in a short depression; stigma peltate, flattened, disc-like, more or less circular from top view. *Fruit* a 2- or 3-valvate capsule, largely inferior, rather thin-walled, soft and leathery-succulent at first, becoming more crustaceous, several–many-seeded, with valves becoming erect but not opening very widely; hypanthium cup-shaped to broadly 2-lobed; disc broad and horizontal, with summit of each locule slightly to prominently raised; inner wall thin, with a faint reticulate pattern of cells, shiny. *Seeds* several to many per cell, broadest towards the base, 4- or 5-facetted, the facets consisting of a long and broad rounded outer surface, two large lateral surfaces and 1 or 2 narrow inner surfaces; testa straw-coloured to medium brown, somewhat shiny, with a reticulate pattern of numerous rows of minute cells or colliculate; hilum small, more or less central or above the centre of basal inner facet. *Chaff pieces* (abortive seeds and/or unfertilised ovules) with a crustaceous testa, facetted, sometimes difficult to distinguish from the seeds.

Etymology. From the Latin *seorsus* – severed or apart, referring to the great disjunctions in this genus, with each species separated from each of the others by distances varying from 600 to 4000 km.

Key to species of *Seorsus*

1. Stamens 10–18 per fascicle. Ovules 12–16 per loculus. Occurring in the Roper River area, Northern Territory ..... **S. intratropicus**

1: Stamens 2–6 per fascicle. Ovules 5–9 per loculus. Occurring in south-western Australia or Borneo.

2. Leaves very broadly elliptic to narrowly obovate, 2–3.5 mm long. Peduncles 0.9–2 mm long; pedicels 1–2 mm long. Ovary 2-locular in all or most flowers. Occurring in the Lake King area, Western Australia ..... **S. clavifolius**

2: Leaves very narrowly obovate to linear in outline, 4–8 mm long. Peduncles 0.4–1 mm long; pedicels absent. Ovary 3-locular in all or most flowers. Occurring in Borneo

3. Sepals horned. Stamens mostly 3 per fascicle. Occurring in northern Sarawak, Malaysia ..**S. taxifolius**

3: Sepals not horned. Stamens mostly 6 per fascicle. Occurring in West Kalimantan, Indonesia ..... **S. aequatorius**

Seorsus aequatorius Rye & Trudgen, *sp. nov.*

Seorso taxifolio affinis sed sepalis integris (non cornutis) et staminibus plus numerosis differt.

Typus: Gunung Klam [Mt Kelam, West Kalimantan], Borneo, 1893–1894, *P. Hallier* 2300 (*holo*: L 0651485).

Shrub height unknown; young branchlets leafy, with prominent bands of pale grey epidermis not much wider than the petioles they subtend. *Leaves* mostly widely spreading, dense on young shoots. *Petioles* 0.7–1 mm long, poorly defined. *Leaf blades* very narrowly obovate to linear in outline, 4–6 mm long, 0.5–0.7 mm wide, *c.* 0.5 mm thick, obtuse, adaxial surface deeply convex, abaxial surface furrowed, with oil glands inconspicuous. *Peduncles* 0.6–0.8 mm long. *Bracteoles* probably persistent, leaf-like but smaller than leaves, *c.* 2.2 mm long. *Pedicels* absent. *Flowers* not seen fully open. *Hypanthium* *c.* 1.8 mm long. *Sepals* depressed-ovate, 0.6–1 mm long, with midrib smooth or somewhat ridged but not horned; margin petaline, denticulate. *Petals* broadly obovate, *c.* 2.3 mm long, white. *Androecium* of 28–30 stamens, with (5)6 stamens per fascicle; fascicles commonly 0.5–0.7 mm wide at base, the outermost filaments *c.* 1 mm long. *Anthers c.* 0.25 mm long, *c.* 0.4 mm wide. *Ovary* 3-locular; ovules 6–8 per loculus. *Style* not seen at maturity. *Fruit* 2/3–3/4-inferior, *c.* 2 mm long, 2.5–3 mm diam.; placentas ± elliptic from top view, *c.* 0.35 mm across. *Seeds c.* 0.7 mm long, *c.* 0.5 mm wide, *c.* 0.5 mm deep, medium brown, with a small modified region on the inner surface with narrowly oblong cells; testa with longitudinal rows of many transversely narrowly oblong cells. *Chaff pieces* more numerous than the fully developed seeds, similar in shape but somewhat smaller. (Figures 1B & 3D)

Distribution and habitat. This Indonesian species is recorded from Mt Kelam, a granite mountain just over 1000 m high in the West Kalimantan region (Kalimantan Barat) of south-western Borneo. The type specimen is labelled Gunung 'Klam', with *gunung* being the Malaysian and Indonesian word for mountain. Apparently the name of this mountain should be written as Kelam but may be pronounced Klam (Gerald Thijsse pers. comm., who confirmed that this collection comes from Mt Kelam). No habitat details are given on the specimen, but the species is likely to occur in a rocky habitat with too little soil to support rainforest.

Phenology. Flowering and fruiting period unknown.

Conservation status. The conservation status of this species needs to be investigated, as it is known only from a very old collection on Mt Kelam. Being fairly isolated from other mountains in Borneo, Mt Kelam is likely to have a suite of endemic species, one of which is the critically endangered carnivorous plant *Nepenthes clipeata* Danser. *Seorsus aequabilis* is likely to be rare, and may be critically endangered or even extinct.

Etymology. Since the only known locality of *Seorsus aequatorius* is very close to the Equator, its specific epithet is based on the Latin word meaning equatorial.

Affinities. Closely related to *Seorsus taxifolius*, differing in its more numerous stamens and its thinner sepals without a horn. A less obvious difference is in the young stems. In *S. taxifolius* the leaves are each subtended by a patch of pale grey epidermis that is much wider than the petiole, and the tissue below has very obvious transverse fissures (Figure 1C) whereas *S. aequatorius* has pale grey strips that are not much wider than the petiole and narrower fissures in the sub-epidermal tissue (Figure 1B). These clear morphological differences, combined with the different location and habitat of the taxon, indicate that it should be treated as a distinct species rather than just a subspecies.

Notes. As there was only one specimen available, in a fairly poor condition with most of its leaves and all of the flowers and fruits in packets rather than attached to the stems, not all characters could be described for this species. Most of the fruits had already opened fully and shed all their seeds but one intact loculus was found to contain eight facetted pieces, all well developed but only the largest one probably a viable seed, all or at least six of the other pieces apparently being chaff.

Seorsus clavifolius (C.A.Gardner) Rye & Trudgen, *comb. nov.*

Astartea clavifolia C.A.Gardner, *J. Roy. Soc. Western Australia* 27: 188 (1942). *Type*: south of Maya, Western Australia, 21 September 1931, *C.A. Gardner* 2704 (*holo*: PERTH 01605062; *iso*: PERTH 01605054, 01605070, 01605089).

Illustrations. Blackall & Grieve (1980: 88), as *Astartea clavifolia*; Gardner's pencil sketch on the isotype PERTH 01605054.

Shrub dense, 0.6–1.4 m high, up to 2 m wide, multi-stemmed at base from a below-ground lignotuber, often with 20–40 stems arising from ground level; young branchlets leafy, more or less terete, with the pale grey epidermis retained longest on the swelling below each petiole. *Leaves* mostly on short branchlets, fairly dense. *Petioles* well defined, 0.3–0.6 mm long. *Leaf blades* very broadly elliptic to narrowly obovate, 2–3.5 mm long, 0.9–1.6 mm wide, 0.4–0.7 mm thick, adaxial surface flat or shallowly concave, abaxial surface convex or with a furrow along the midrib, sometimes rugose with prominent oil glands; apex obtuse or almost truncate, not or scarcely mucronulate. *Peduncles* usually at 1–6 nodes towards ends of branchlets, 0.9–2 mm long. *Bracteoles* often persistent in fruit, 0.7–1.3 mm long, 0.4–0.7 mm wide, with apex hooded, reddish. *Pedicels* 1–2 mm long. *Flowers* 7–10 mm diam., sometimes with a slight pink flush. *Hypanthium* 1.8–2.5 mm long. *Sepals* mostly broadly ovate, 0.9–1.6 mm long, 1.5–2.3 mm wide, often reddish outside, herbaceous midrib smooth to distinctly ribbed dorsally. *Petals* 3–4 mm long, white or possibly sometimes pale pink. *Androecium* of 17–23 stamens, in fascicles of 2–6 (most commonly 4), exceeding sepals; fascicles *c.* 0.5 mm wide at base, the longest filaments 1–1.6 mm long. *Anthers* 0.3–0.4 mm long, 0.5–0.8 mm wide. *Ovary* 2(3)-locular; placenta almost conic, with a central attachment; ovules 6–9 per loculus, radially arranged and all meeting at the centre of the placenta. *Style* 1.3–1.7 mm long, dark red, base separated

by 0.6–0.8 mm from placentas; stigma 0.2–0.3 mm diam. *Fruit c.* 2/3 inferior, somewhat compressed when 2-locular, hemispheric when 3-locular, 2.2–3 mm long, 3–3.5 mm x *c.* 2 mm across or rarely 3–3.5 diam.; hypanthium green and reticulately pitted in adnate part, dark red-brown and smooth distally; disc flat except for the 2(3) slightly raised valves; placentas extending into the loculus for 0.4–0.6 mm but only *c.* 0.4 mm diam. *Seeds* 1.2–1.4 mm long, 0.6–0.8 mm wide, 0.6–0.9 mm deep, without an obvious modified region on the inner surface, the hilum near centre of basal inner facet; testa medium brown, minutely and shallowly colliculate. *Chaff pieces* similar to the seeds but tending to be narrower and often with somewhat sunken facets. (Figure 2A–E)

Other specimens examined. WESTERN AUSTRALIA: Chinocup Nature Reserve, 16 Nov. 1992, *A. Coates* 3731 (PERTH); W shore of Lake King, *c.* 500 m N or road, 11 Dec. 2003, *J.A. Cochrane* 4838 (K, PERTH); 2.3 km E of Lake Chinocup Rd on old track into nature reserve, 2 Feb. 2004, *J.A. Cochrane* 4961 (PERTH); Lake King Nature Reserve, 19 Oct. 1995, *R.J. Cranfield* 10600 (MEL, PERTH); Chinocup, 11 Oct. 1999, *R. Cugley* 95 (PERTH); N side of Rasmussen Rd, 11 Sep. 2000, *R. Cugley* 127 (L, PERTH, UC); 8 miles [13 km] W of Lake King, 31 Oct. 1965, *K.R. Newbey* 1906 (PERTH); 2.3 km E of Chinocup Rd on track that originates 350 m S of Sutherland track, 26 Oct. 1997, *D. Papenfus* 708 (PERTH); N of Lake King–Newdegate road on track 12.8 km W of Lake King, 29 Oct. 1997, *D. Papenfus* 716 *& K. Macey* (PERTH); Allen Rd, 1.2 km E of Newdegate–Ravensthorpe road, *c.* 13 km S of Lake King, 29 Oct. 1997, *D. Papenfus* 721 *& K. Macey* (PERTH); 0.8 km N of Newdegate–Ravensthorpe road on a track that starts not far from western edge of Lake King salt lake, *B.L. Rye* 250109 *& M.E. Trudgen* (BRI, PERTH); 2.3 km E of Chinocup Rd on a track that starts *c.* 0.35 km S of Sutherland Rd, 13 Jan. 2005, *B.L. Rye* 250119 *& M.E. Trudgen* (CANB, PERTH); 2.3 km E of Chinocup Rd on a track that starts *c.* 0.35 km S of Sutherland Rd, 13 Jan. 2005, *B.L. Rye* 250120 *& M.E. Trudgen* (AD, PERTH); W end of Lake King salt lake, 17 Oct. 1997, *Peter G. Wilson & N. Lam* UNSW23727 (NSW).

Distribution and habitat. Endemic to the South West Botanical Province, occurring on the sandy margins of salt lakes (commonly 1–1.5 m above level of lake) or on raised islands within them in the Pingrup to Lake King area. Most records are from *Melaleuca* high shrubland, with one record from *Eucalyptus angustissima* subsp. *quaerenda* open mallee over heath. Below the *Melaleuca* layer, *Seorsus* may form a closed or open shrubland, and other genera commonly present are *Darwinia*, *Leucopogon* and *Lepidosperma*. (Figure 4B)

Phenology. Flowering has been recorded from September to November. Mature fruits were present on specimens collected from late October to January.

Conservation status. Conservation Codes for Western Australian Flora: Priority Two. This species is common at several localities, but one of these sites appears to be being mined for gypsum. Seeds have been deposited in the Millennium Seed Bank.

Affinities. This very distinctive species is readily distinguished from the other members of its genus by its broader shorter leaves with a very well defined petiole, its usually 2-locular ovary, and its habitat on the margins of salt lakes. It is possibly the only lignotuberous species in the genus and it has the longest pedicels and largest seeds.

Notes. Multiple, well-separated stems are produced from the lignotuber, and there is commonly a mound built up over the base of the plant. Young plants may have only a few stems but older ones commonly have 20–40 stems at ground level. Insect damage to the leaves is common on some specimens, with

a variety of scale insects observed, and one specimen (*Peter G. Wilson & N. Lam* UNSW23727) also has rounded grey galls *c.* 2.5 mm long terminating some of its branchlets.

All recent flowering collections of this species have been from the margins of salt lakes near Pingrup and Lake King in late October and November. Gardner made collections with Blackall (numbers 1371 etc.) from between Lake Carmody and Lake Biddy on 19 November 1931 and others on his own (numbers 2929–2933) from the vicinity of Lake King on 24 November 1931. Perhaps some mix up with the numbering of his specimens resulted in the type specimen of *Seorsus clavifolius* being given an incorrect locality and date. However, the name *Astartea clavifolia* was entered into Gardner's field notebook and the descriptive details given for the plant appear to tally with this species. According to the field notes, the locality was south of Maya in yellow sand in a thicket of *Melaleuca uncinata*. If the Maya locality is correct, then there is a large disjunction of over 400 km in the known range of *S. clavifolius*. This would make the generic name, chosen in reference to the disjunction of its members, even more appropriate. However, the different habitat type recorded suggests that the Maya record is in error.

Gardner (1942: 188) observed that his new species differed from the type species of *Astartea* in having "much shorter and broader clavate leaves which are never clustered" and in its 2-locular ovary. Probably fooled by the strange orientation and separation of the loculi on each anther, he gave the stamen number per fascicle as *c.* 8, apparently counting each loculus as a stamen. Actually, the fascicles on the holotype commonly have 4 stamens. Occasional 6-merous flowers have been observed, which may have more than the usual number of stamens per flower since there is an extra fascicle of them.

Seorsus intratropicus (F.Muell.) Rye & Trudgen, *comb. nov.*

Astartea intratropica F.Muell., *Fragm.* 1: 83 (1859). – *Baeckea intratropica* (F.Muell.) Nied. in A. Engler & K. Prantl, *Nat. Pflanzenfam.* III: 7, 99. (1893). *Type citation*: In clivis rupestribus passim irregius et circum fontes prope origenem fluviorum Limmen-bight et Roper River. *Type*: rocky cliffs and springs near the origins of Limmen Bight River and Roper River, [Northern Territory], *F. Mueller s.n.* (*holo*: MEL *n.v.*).

Erect spreading *shrub*, 1–1.7(3) m tall; young branchlets leafy, somewhat compressed at right angles to the orientation of the pair of leaves directly above, with prominent bands of pale grey epidermis below each petiole. *Leaves* antrorse to widely spreading, dense on young shoots, soon shed. *Petioles* 0.6–0.9 mm long, often poorly defined. *Leaf blades* very narrowly obovate in outline, 6–8.5 mm long, 0.5–0.8 mm wide, 0.8–1 mm thick, obtuse, adaxial surface very deeply convex, abaxial surface furrowed, with scattered moderately large oil glands. *Peduncles* at 1–8 nodes towards the end of each branchlet, 1.0–1.2 mm long. *Bracteoles* apparently deciduous, *c.* 1.5 mm long, *c.* 0.6 mm wide. *Pedicels* 0.4–0.6 mm long, 5-ribbed. *Flowers* 6–7.5 mm diam. *Hypanthium* 1.9–2.5 mm long. *Disc* minutely dotted with prominent white glands. *Sepals* depressed to broadly ovate, 1.0–1.2 mm long, 1.5–1.6 mm wide, erect, dorsally ridged on midrib, possibly somewhat reddish outside. *Petals* broadly obovate, 2.3–3 mm long, creamy white. *Androecium* of usually 57–70 stamens but up to 78 recorded, with 10–15(18) stamens per fascicle; fascicles *c.* 1 mm wide at base, the filaments connate for half or more of their length and up to 2 mm long. *Anthers c.* 0.2 mm long, *c.* 0.4 mm wide. *Ovary* 3-locular; placenta broadly elliptic with marginal small circular attachment points for the ovules, flat, very broadly attached by an oval hollow structure; ovules 12–16 per loculus. *Style* 1.4–1.8 mm long, base separated by 0.4–0.5 mm from the placentas; stigma *c.* 0.3 mm diam. *Fruit* 2/3–3/4 inferior, *c.* 2.5 mm long, *c.* 2.5 mm diam.; hypanthium cup-shaped; disc flat around the margin, somewhat raised in centre into 3 valves, conspicuously dotted with minute white oil glands; placentas elliptic

Figure 5. *Seorsus intratropicus*, photographs by Andrew Mitchell (voucher *A.A. Mitchell* 7017). A – plant habit; B – flowering stem; C – habitat.

with acute ends, *c.* 0.7 mm long, *c.* 0.35 mm wide, *c.* 0.15 mm thick. *Seeds* laterally compressed, 0.8–0.9 mm long, *c.* 0.35 mm wide, 0.6–0.7 mm deep, the basal and distal inner facets roughly equal and the hilum above the middle of the basal inner facet, with a large modified region on the inner surface that is more or less triangular from side view and has narrowly oblong cells; testa pale yellowish brown, with longitudinal rows of many transversely oblong cells. *Chaff pieces* probably numerous, similar in appearance to seeds except that they tend to be only *c.* 0.2 mm wide, with the crustaceous wall similar to or thicker than that of the seeds (Figures 2F–I, 3E & 5)

Specimens examined. NORTHERN TERRITORY. *c.* 40 km SSW of the Natham River Homestead, 27 Aug. 1985, *P.K. Latz* 10117 (NSW, PERTH); 3 km S of Limmen Gate, S of Roper Bar, Bohemia Downs Station, 14 Sep. 1995, *P.K. Latz* 14564 (NSW); near Limmen Gate, S of Roper Bar, Bohemia Downs Station, 23 Aug. 2001, *A.A. Mitchell* 7017 (NSW).

Distribution and habitat. Endemic to the Limmen Bight region of Northern Territory, recorded from near Limmen Gate on Bohemia Downs Station. *Astartea intratropica* grows in cracks on sandstone blocks and has recently been recorded as the dominant species in this restricted habitat. Mueller (1859) described the habitat as wet rocky slopes and around springs and Bentham (1867: 91) described it as 'ravines of the sandstone table-land'.

Phenology. Flowers and fruits recorded from late August to mid-September.

Conservation status. This taxon is known either from just one locality or a few collections in close proximity. It was reported as being fairly common in 2001 at a location on a pastoral station.

Affinities. Readily distinguished from all other species of *Seorsus* by its more numerous stamens and ovules. In its leaf morphology it is similar to the two species in Borneo but it is like the Australian species *S. clavifolius* in having variable stamen numbers per fascicle. It is intermediate between the south-western and Borneo species in its pedicel length.

Notes. This description is based primarily on the single specimen located in PERTH, although the NSW specimens examined appeared to be very similar in their morphology. *Seorsus intratropicus* is probably not lignotuberous, but its rocky habitat presumably gives it significant protection from fires.

Seorsus taxifolius (Merr.) Rye & Trudgen, *comb. nov.*

Baeckea taxifolia Merr., *Sarawak Mus. J.* 3: 534, 537 (1928). – *Babingtonia taxifolia* (Mer.) A.R Bean, *Austrobaileya* 4: 632 (1997). *Type*: Mt Murud, Borneo, October 1922, *E. Mjöberg* 111 (*lecto*: UC; *isolecto*: BM 000028875 *n.v.* image seen, K 000349801 *n.v.* image seen).

Prostrate to erect *shrub*, up to 1.3 m tall; young branchlets leafy, with the prominent regions of pale grey epidermis much wider than petioles they subtend. *Leaves* mostly widely spreading, dense on young shoots, soon shed. *Petioles* 1–1.5 mm long, poorly defined. *Leaf blades* very narrowly obovate to linear in outline, 5–8 mm long, 0.5–0.8 mm wide, 0.4–0.7 mm thick, obtuse, adaxial surface deeply convex, abaxial surface furrowed, with oil glands inconspicuous. *Peduncles* at 1–3 nodes towards the end of each branchlet, 0.4–1 mm long. *Bracteoles* persistent, leaf-like but smaller than leaves, commonly *c.* 3 mm long. *Pedicels* absent. *Flowers c.* 6 mm diam. *Hypanthium* 1.5–2 mm long. *Sepals* depressed ovate, 0.8–1.1 mm long, with midrib thickened and protruding in a short horn *c.* 0.3 mm long. *Petals* broadly obovate, *c.* 2 mm long, white. *Androecium* normally of 15 stamens, with 3 stamens per fascicle; fascicles *c.* 0.4 mm wide at base; outermost filaments *c.* 1.3 mm long. *Anthers c.* 0.2 mm long, *c.* 0.4 mm wide. *Ovary* 3-locular; placenta broadly elliptic with marginal small circular attachment points for the ovules, flat, very broadly attached by an oval hollow structure; ovules 6 or 7 per loculus. *Style* 1–1.5 mm long, base separated (in fruit) by *c.* 0.7 mm from the placentas; stigma *c.* 0.3 mm diam. *Fruit* 2/3–3/4-inferior, 1.8–2 mm long, 2.3–3.3 mm diam.; placentas elliptic from top view, moderately thick. *Seeds* 0.6–0.7 mm long, *c.* 0.6 mm wide, *c.* 0.5 mm deep, the basal and distal inner facets roughly equal and the hilum above the middle of the basal inner facet, with a modified region on the inner surface with narrowly oblong cells; testa pale yellowish brown, with longitudinal rows of many transversely narrowly oblong cells. *Chaff pieces* apparently more numerous than the fully developed seeds, more compressed in shape. (Figure 1C)

Specimens examined. SARAWAK, BORNEO: Mt Murud, Oct. 1922, *E. Mjöberg* 84 (UC); altitude 2,200 m, Mt Murud, Kalabit Highlands, 7 Apr. 1970, *H.P. Nooteboom & P. Chai* 0216 (L); altitude 7,000 ft [*c.* 2400 m], Mt Murut, Lawas, 9 Oct. 1967, *I. Paie* S26456 (L).

Distribution and habitat. This species occurs in the Malaysian state of Sarawak, in the northern part of the island of Borneo. It grows on the sandstone mountain, Mt Murud, at altitudes of over 2000 m in open shrublands 'on rocky slopes with little soil'. The name of this mountain is sometimes spelt Murut, as on the *I. Paie* S26456 specimen cited above.

Phenology. Flowers and fruits recorded in early to late October, also recorded in flower in early April.

Conservation status. Apparently endemic to the highest mountain in Sarawak, Mt Murud, which is about 2400 m high and has a summit ridge about four kilometres long. Few major botanical expeditions have been undertaken in this difficult terrain; there was one in 1995 but *Seorsus* was not collected (Beaman 1999).

Affinites. This species can be easily distinguished from other members of its genus by its horned sepals. It also appears to have the largest bracteoles in the genus. See the notes under its closest relative, *Seorsus aequatorius*.

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